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Evaluation of diet and nutritional status in patients aged 45+ with diagnosed, pharmacologically treated arterial hypertension

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Abstract

Introduction: Diet plays a significant role in the prevention and treatment of arterial hypertension. Appropriate diet makes it possible to maintain adequate body weight and improve biochemical blood parameters. The aim of the study was to assess nutritional status of arterial hypertension patients in terms of their diet.

Material and methods: The study involved 55 patients diagnosed with arterial hypertension aged 45-70 years. Diet was evaluated using a 24-hour 7-day diet recall interview. In the course of the diet recall interview arterial pressure was measured three times at regular times, after a 15-minute rest period, and the recorded values were averaged. Nutritional status was assessed based on anthropometric measurements (height, body weight, waist circumference, hip circumference) and the resulting nutrition status indexes, i.e. BMI (body mass index), WHR (waist-hip ratio) as well as values of biochemical blood parameters.

Conclusions: It was found that a considerable proportion of patients are overweight or obese, have an inappropriate lipid profile and elevated blood glucose levels. Daily food rations (DFR) were inappropriately balanced. Daily food rations were deficient in energy, carbohydrates, dietary fibre, PUFA and folates. It was found that inadequate diet was correlated with nutritional status, lipid profile parameters and arterial blood pressure.

Key words: diet recall interview, anthropometric parameters, macronutrients, minerals, vitamins.

Introduction

A healthy diet constitutes the foundation for adequate health and promotes a reduced risk of cardiovascular diseases, including arterial hypertension. Appropriately balanced diet plays a significant role in the prevention and therapy of arterial hypertension. A rationalised diet may be an important tool considerably supporting treatment of arterial hypertension at any stage of the disease, which in many cases makes it possible to reduce doses of administered antihypertensives or eliminate them completely [2, 3]. In the diet of patients diagnosed with arterial hypertension the need to reduce table salt and total fat intake is stressed, along with an adequate supply of antioxidant vitamins, minerals and dietary fibre [4]. A change in the diet, particularly an increased intake of dietary fibre and mono- and polyunsaturated fatty acids, and a reduced intake of saturated fatty acids, dietary cholesterol and simple sugars, additionally alleviates lipid disorders, frequently accompanying arterial hypertension [5]. It needs to mentioned here that recently the incidence of overweight and obesity has increased dramatically, currently reaching an epidemic scale, while an adequate supply of energy, proportionate to energy requirement, prevents overweight and obesity, at the same time limiting their metabolic consequences [2]. Unfortunately, healthy diet is frequently neglected. The aim of this study was to assess diets of patients diagnosed with arterial hypertension, who due to their condition should be additionally motivated to introduce changes in their lifestyles.

Material and methods

Investigations were conducted with the participation of 55 patients diagnosed with arterial hypertension and undergoing treatment: 29 women aged 55.5 ± 7.2 years, and 26 men aged 57.3 ± 7.1 years. The protocol of the study was approved by the Research Ethics Committee of Poznan University of Medical Sciences and registered as no. 86/09.

The research tool used to evaluate diet was provided by a 7-day diet recall interview reporting amounts and types of consumed foodstuffs, dishes and drinks. The Photo Album of Foodstuffs and Dishes was used in order to accurately determine the size of consumed servings. The Dietetyk computer program was used to assess energy and nutritive value of daily food rations

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(DFR) taking into consideration cooking losses. Recorded data were averaged and compared with the mean weighed recommended allowance, determined based on average requirements [1], taking into consideration sex, age, body mass and moderate physical activity (PAL = 1.6). Mean weighted average requirements, in this paper referred to as the requirement, were specified for the following nutrients: energy, protein, fats, carbohydrates, vitamins and minerals. When assessing intake of saturated, monounsaturated and polyunsaturated fatty acids as well as cholesterol, nutritional recommendations were followed, assuming their percentage shares in total energy value of food rations as < 10% from saturated fatty acids (SFA), 12% from monounsaturated fatty acids (MUFA), and 8% from polyunsaturated fatty acids (PUFA). For cholesterol the adopted recommendation was < 300 mg. Diet was evaluated based on the degree in which the calculated allowances were met.

Tab. I. Selected anthropometric parameters and biochemical blood parameters as well as arterial blood pressure values in patients diagnosed with arterial hypertension ($\bar{x}$ ± SD)

Parameter	Examined group	
	Women	Men
Height [m]	1.65 ± 0.07[a]	1.73 ± 0.09[b]
Body weight [kg]	71.1 ± 28.88[a]	83.77 ± 11.57[b]
BMI [kg/m^2]	26.23 ± 10.41	28.16 ± 3.87
Waist circumference [cm]	85.86 ± 22.59[a]	100.96 ± 12.62[b]
Hip circumference [cm]	105.03 ± 18.70	107.12 ± 10.36
WHR	0.81 ± 0.09[a]	0.94 ± 0.06[b]
RBC [T/L]	4.75 ± 0.53	4.61 ± 0.48
WBC [G/L]	7.39 ± 1.85	7.13 ± 1.81
HGB [g/dL]	11.91 ± 3.18	10.66 ± 2.60
PLT [G/L]	292.07 ± 69.43	290.79 ± 81.91
HCT [%]	43.21 ± 4.47[b]	40.79 ± 2.54[a]
MCV [fL]	90.49 ± 4.97	90.81 ± 6.31
MCHC [g/dL]	29.10 ± 5.89	28.10 ± 5.55
MCH [pg]	21.60 ± 12.22	20.63 ± 13.08
ESR [mm/h]	13.64 ± 4.83	16.17 ± 5.52
Total cholesterol [mg/dl]	189.61 ± 30.51[a]	223.05 ± 33.48[b]
C-HDL [mg/dl]	57.11 ± 17.66	64.10 ± 17.32
C-LDL [mg/dl]	127.46 ± 34.10	136.63 ± 31.79
Fasting glucose [mg/dl]	97.83 ± 14.5	106.33 ± 18.39
Systolic pressure [mm Hg]	126.75 ± 12.13[a]	137.66 ± 12.34[b]
Diastolic pressure [mm Hg]	78.32 ± 10.06	83.57 ± 9.42

[a, b] – statistically significant difference between women and men in the examined group at $p < 0.05$
RBC – red blood cells, WBC – white blood cells, HGB – haemoglobin, PLT – thrombocytes, HCT – haematocrit, MCV – mean cell volume, MCHC – mean corpuscular haemoglobin concentration, MCH – mean corpuscular haemoglobin, ESR – erythrocyte sedimentation rate

In the course of the diet recall interview, arterial pressure was measured three times at regular times, after a 15-minute rest period, and the recorded values were averaged.

Nutritional status was assessed based on anthropometric measurements (height, body weight, waist circumference, hip circumference) and the resulting nutrition status indexes, i.e. BMI (body mass index), WHR (waist-hip ratio) as well as values of biochemical blood parameters. Biochemical analyses covered the following parameters: red blood cells (RBC), white blood cells (WBC), haemoglobin (HGB), thrombocytes (PLT), haematocrit (HCT), mean cell volume (MCV), mean corpuscular haemoglobin concentration (MCHC), mean corpuscular haemoglobin (MCH), erythrocyte sedimentation rate (ESR), total cholesterol (TC), low- and high-density lipoprotein (LDL and HDL) cholesterol, and fasting blood glucose level. Laboratory analyses were performed at a certified analytical laboratory.

Statistical analyses were conducted using the STATISTICA 6.0 PL software package by StatSoft. Significance of differences between intake of energy and nutrients, anthropometric parameters and biochemical blood indexes depending on the sex of patients was evaluated by one-way analysis of variance (ANOVA). Dependencies between values of arterial blood pressure, anthropometric parameters and biochemical blood parameters, and diet factors (energy value and nutritive value of DFR) were assessed using linear regression. Significant differences were denoted with different superscript letters.

Results

Mean values of anthropometric measurements, biochemical blood parameters and arterial blood pressure in patients diagnosed with arterial hypertension are given in Table I. It was found that mean BMI value both for women and men fell within the range considered as overweight [6]. It was observed that 62% of women and only 23% of men had normal body weight, while overweight was found in 21% of women and 46% of men and obesity was recorded in 14% of women and 31% of men.

Mean waist circumference was significantly lower in women than in men, while in both sexes it exceeded boundary values [6].

Calculation of WHR made it possible to determine figure type (obesity) in examined individuals. It was found that 52% of women had abdominal type obesity, while a gynoid figure was characteristic of men (85%).

Mean values of most biochemical blood parameters fell within the range of reference values for both women and men [7]. Lowered mean levels of HGB, MCHC and

MCH were observed in both women and men, while a reduced HCT blood concentration was found in men.

Total blood cholesterol level in men was significantly higher than in women and it exceeded reference values. At the same time an elevated blood cholesterol level was found in 36% of women. Mean concentration of LDL cholesterol fraction also exceeded the recommended level in both women and men. Moreover, a reduced concentration of HDL cholesterol fraction was recorded in 9% of women.

Moreover, a significant difference between women and men was also found in values of systolic arterial blood pressure, which was significantly higher in men.

Mean fasting glucose concentration was elevated in the group of men. Moreover, reference values were exceeded in 25% of women.

Table II presents mean intake of energy and macronutrients supplied in DFR of patients along with their uptake percentages.

Analysis of diets showed an inappropriate intake of energy with consumed food among both women and men, while a significantly greater intake of energy was recorded for men.

Mean intake of protein and fat in women and men fell within the limits of the allowance, although it was markedly higher in men. Moreover, it was found that as many as 31% of men exceeded the recommended dietary fat intake. In contrast, intake of carbohydrates was definitely too low in both groups.

In the analysed DFR of the patients the share of energy coming from macronutrients was not properly balanced. An excessive share of energy from fat and protein was observed in relation to the amount of energy obtained from carbohydrates.

Mean intake of sucrose exceeded the upper limit in women. However, it needs to be stressed that as many as 35% of men consumed excessive amounts of this nutrient.

Mean level of dietary fibre was markedly higher in the diets of men, while intake of dietary fibre was too low in both groups. Optimal intake of dietary fibre was recorded in only 10% of women and 34% of men.

Mean intake of cholesterol in men was significantly higher than in women and it exceeded 300 mg/d, whereas in 38% of women cholesterol intake was close to that value and only 3.45% of women consumed excessive amounts of cholesterol.

Mean intake of SFA and MUFA fell within the limits of recommended allowances and it was significantly higher in men than in women. However, it was observed that 17.24% of women and 37.93% of men exceeded the SFA allowance, while the levels for 52% of women and 34% of men were within the upper limits of the allowance. In turn, mean PUFA intake was definitely too low in both groups. Moreover, a considerable imbalance was shown in the case of energy from fatty acids. The share of energy coming from SFA exceeded the recommended level. A low intake of energy from PUFA was also observed, while it was significantly higher in men.

Table III presents mean intake of minerals and vitamins in DFR of the patients included in the study and the percentage of dietary allowance uptake for these nutrients.

Analysis of intake of minerals and vitamins showed their considerable imbalance. Deficits of the patients' DFR were found for potassium, calcium and magnesium; moreover, women consumed insufficient amounts of iron. Intake exceeding the recommended allowance in both groups was recorded for phosphorus, while the diet of men contained excessive amounts of sodium and copper. In both women and men intake of vitamins D and C as well as folates was insufficient; moreover, DFR of women was found to be deficient in thiamin. In both groups intake of vitamin B_{12} exceeded the recommended allowance, while for men that of vitamin B_6 also did so. It was found that men consume significantly greater amounts of most vitamins and minerals.

Tab. II. Energy and macronutrients in DFR of patients ($\bar{x}$ ± SD)

Component	Examined group			
	Women	% allowance uptake	Men	% allowance uptake
Energy [kcal]	1538.31 ± 294.11[a]	74	2126.74 ± 416.12[b]	81
Energy [MJ]	6.44 ± 1.23[a]	74	8.90 ± 1.74[b]	81
Protein [g]	59.07 ± 12.32[a]	92	79.45 ± 18.22[b]	105
Fat [g]	64.78 ± 12.96[a]	93	97.7 ± 20.32[b]	112
Carbohydrates [g]	179.75 ± 50.31[a]	59	232.38 ± 60.16[b]	61
Protein [% E]	15.5 ± 2.58	129	14.92 ± 1.91	124
Fat [% E]	38.28 ± 6.23	128	41.76 ± 6.27	139
Carbohydrates [% E]	46.21 ± 7.17	80	43.32 ± 5.33	75
Sucrose [g]	35.04 ± 18.04	119	40.82 ± 20.25	109
Dietary fibre [g]	15.3 ± 4.22[a]	63	18.39 ± 5.33[b]	76

[a, b] – statistically significant difference between women and men in the examined group at $p < 0.05$

Tab. III. Minerals and vitamins in DFR of patients ($\bar{x}$ ± SD)

Nutrient	Examined group			
	Women	% allowance uptake	Men	% allowance uptake
Sodium [mg]	1474.69 ± 480.6[a]	103	2312.03 ± 1023.38[b]	165
Potassium [mg]	2542.15 ± 444.44[a]	54	3071.01 ± 734.00[b]	65
Calcium [mg]	544.83 ± 172.29	48	563.49 ± 221.93	54
Phosphorus [mg]	1003.0 ± 222.65[a]	143	1253.4 ± 312.34[b]	179
Magnesium [mg]	236.61 ± 55.49[a]	74	293.14 ± 87.96[b]	70
Iron [mg]	8.65 ± 2.14[a]	65	11.18 ± 2.75[b]	112
Zinc [mg]	7.98 ± 1.85[a]	100	10.56 ± 2.42[b]	96
Copper [mg]	0.98 ± 0.25[a]	109	1.19 ± 0.38[b]	133
Vitamin A [µg]	791.27 ± 745.64	113	901.84 ± 518.32	100
Vitamin D [µg]	2.75 ± 1.77	31	3.73 ± 2.27	37
Vitamin E [mg]	6.79 ± 1.82[a]	85	10.59 ± 6.50[b]	106
Thiamin [mg]	0.81 ± 0.18[a]	74	1.25 ± 0.33[b]	96
Riboflavin [mg]	1.20 ± 0.26[a]	109	1.41 ± 0.34[b]	108
Niacin [mg]	12.61 ± 3.18[a]	90	17.15 ± 4.54[b]	107
Vitamin B_6 [mg]	1.47 ± 0.28[a]	103	1.92 ± 0.48[b]	118
Folates [µg]	140.26 ± 38.68[a]	35	166.30 ± 52.51[b]	42
Vitamin B_{12} [µg]	3.43 ± 2.31	143	3.86 ± 2.14	161
Vitamin C [mg]	40.80 ± 21.89	54	45.14 ± 23.45	50

[a, b] – statistically significant difference between women and men in the examined group at $p < 0.05$

Analysis of the relationship between diet and nutritional status showed that there is a positive dependence between the WHR value and the amount of energy intake with the diet ($R = 0.412$, $p < 0.01$), intake of fat ($R = 0.533$, $p < 0.001$), SFA ($R = 0.334$, $p < 0.05$), MUFA ($R = 0.427$, $p < 0.01$), PUFA ($R = 0.408$, $p < 0.01$) and the percentage of energy from fat ($R = 0.353$, $p < 0.01$), MUFA ($R = 0.270$, $p < 0.05$), PUFA ($R = 0.322$, $p < 0.05$) and the intake of cholesterol ($R = 0.322$, $p < 0.05$).

Similarly, waist circumference was positively correlated with intake of fat ($R = 0.280$, $p < 0.05$) and the percentage of energy from fat ($R = 0.453$, $p < 0.001$).

It was also found that with an increase in the share of energy coming from fat an increase is observed in body weight ($R = 0.365$, $p < 0.01$) and BMI ($R = 0.460$, $p < 0.001$).

Analysis of correlations between nutrients and biochemical blood parameters and arterial blood pressure showed that there is a positive dependence between systolic blood pressure and fat intake ($R = 0.340$, $p < 0.05$), percentage share of energy from fat ($R = 0.344$, $p < 0.05$) and cholesterol intake ($R = 0.317$, $p < 0.05$). In turn, diastolic pressure was positively correlated with fat intake ($R = 0.278$, $p < 0.05$), SFA ($R = 0.298$, $p < 0.05$) and the percentage of energy from fat ($R = 0.277$, $p < 0.05$) and from SFA ($R = 0.299$, $p < 0.05$).

It was also found that total blood cholesterol level is positively correlated with the intake of energy ($R = 0.321$, $p < 0.05$), fat ($R = 0.396$, $p < 0.01$), SFA ($R = 0.2965$, $p < 0.05$) and dietary cholesterol ($R = 0.290$, $p < 0.05$). At the same time a positive dependence was shown between HDL cholesterol concentration and SFA intake ($R = 0.532$, $p < 0.05$) and energy from SFA ($R = 0.551$, $p < 0.01$).

Based on the assessment of the dependence between anthropometric parameters and biochemical blood indicators and arterial pressure it was found that systolic blood pressure increased with an increase in body weight, BMI, waist circumference and WHR ($R = 0.345$, $p < 0.01$; $R = 0.30$, $p < 0.05$; $R = 0.448$, $p < 0.001$ and $R = 0.471$, $p < 0.001$, respectively). Diastolic pressure increased with an increase in WHR ($R = 0.333$, $p < 0.05$).

Moreover, a positive correlation was observed between WHR and blood cholesterol level ($R = 0.367$, $p < 0.01$). At the same time, HDL cholesterol concentration decreased with an increase in body weight ($R = 0.492$, $p < 0.05$) and BMI ($R = 0.487$, $p < 0.05$).

Discussion

Evaluation of nutritional status of the examined cohort showed that a considerable percentage of patients

diagnosed with arterial hypertension are overweight or obese, which was also confirmed by observations reported by other authors [8, 9]. At the same time, dietary energy intake was found to be insufficient in relation to the recommended allowances. This suggests that patients deliberately reduced amounts of consumed foodstuffs. A similarly low energy value of DFR was found in a study by Bronkowska *et al*. [10] and Terlikowska *et al*. [11].

It is particularly disturbing that in most women and men high values were recorded for waist circumference, which is connected with an elevated risk of metabolic disorders [6]. Based on WHR abdominal obesity was diagnosed in over 50% of women and 15% of men. These results correspond with a study by Terlikowska *et al*. [11], who diagnosed android obesity in 59% of women aged 40-73 years. As suggested by many researchers [5, 6], this type of obesity is strongly correlated with elevated arterial blood pressure as well as lipid disorders and risk of cardiovascular diseases. In turn, reducing body weight by as little as 4.5 kg results in a decrease of arterial pressure in obese patients and at the same time makes it possible to reduce doses of antihypertensive drugs [5].

Assessment of nutrient intake with DFR showed several irregularities. We need to stress here an excessive share of energy from fat, at a low intake of carbohydrates and dietary fibre. Similar results in the group of individuals with primary arterial hypertension were reported by Suliburska *et al*. [3]. The observed excessive share of energy from protein, particularly of animal origin, is also a disadvantageous phenomenon. Animal protein may lead to an increased methionine content in DFR, which is manifested in elevated blood homocysteine content and as a consequence leads to an increase in arterial blood pressure and intensification of oxidative stress, including atheromatosis [8]. A high share of energy from protein in the population of Polish women was confirmed by a study by Bronkowska [10]. An adverse relationship was also observed in the amount of energy from fatty acids. The share of energy from SFA was found to be too high, at a simultaneous low share of energy from PUFA. Additionally, high cholesterol intake was reported in a considerable percentage of men and women. A similar, atherogenic diet was observed by Bronkowska *et al*. [10] in a group of perimenopausal women. Particularly disturbing data were supplied by a study conducted on a cohort of young men by Suczko *et al*. [12], who also observed inappropriate diet leading to a significant risk of obesity and cardiovascular diseases. An excessive share of energy from SFA and a high cholesterol intake, amounting to 341 mg in men and 241 mg in women, was recorded in the population of adult Americans [2].

Low intake of calcium, magnesium and potassium observed in this population as well as in other studies [3, 8] may lead to many adverse changes in the cardiovascular system. Houston *et al*. [13] and Myers *et al*. [14] stressed that there is an inverse correlation between intake of calcium, magnesium and potassium, and values of arterial blood pressure. Głuszek [15] suggested that it is particularly important to maintain adequate proportions between intake of sodium, calcium, magnesium and potassium. In turn, excessive sodium intake with potassium deficit leads to an increase in blood pressure [15, 16]. In this study we observed excessive sodium intake in 65% of men and 31% of women, but no dependence was found between sodium intake and values of arterial blood pressure. However, we need to consider the fact that some individuals are sodium-sensitive, while others are sodium-resistant [17]. Gu *et al*. [18], based on a study conducted on 1906 inhabitants of China and a review of other papers, stated the existence of a sodium sensitivity gene, which is connected with the risk of arterial hypertension in response to a high-sodium diet. In the examined group of women an inadequate supply of iron was also recorded, while both insufficient and excessive intake of this element causes an increase in blood pressure [16].

We also need to stress here a relatively low intake of antioxidant vitamins in the examined group of patients. Although only vitamin C intake was below the limits of the recommended allowance, high deviations from the mean intake of vitamins E and A suggest that a considerable proportion of the patients consumed too low amounts of these vitamins. Moreover, decreased activity of antioxidant systems is observed in patients with cardiovascular diseases, which determines an enhanced requirement for exogenous antioxidants, adequate intake of which reduces dysfunction of vascular endothelium and decreases blood pressure [8, 19]. Another disturbing fact is connected with a very low intake of folates, observed in both examined groups of women and men. It was found that the consumption of folates is inversely correlated with the concentration of homocysteine and the risk of cardiovascular diseases. Such a low intake of folate is also observed in the group of young people [12]. Intake of vitamins B_6 and B_{12}, also affecting homocysteine level, was sufficient in most individuals and it even exceeded the recommended allowance.

These investigations are confirmed by the results reported by many researchers [3, 20, 21] indicating that patients with arterial hypertension very often have an inappropriate lipid profile. This is probably connected with an inappropriate diet. This study showed a positive correlation between total blood cholesterol concentration and intake of energy, fat, SFA and dietary cholesterol. Suczko *et al*. [12] also found a dependence between cholesterol concentration and intake of fat, SFA and cholesterol. At the same time, in this study an increase was observed in the level of HDL lipoprotein with an increase in SFA intake and the share of energy

from SFA. This is consistent with the results reported by other researchers [2, 22] showing that SFA cause an increase in the level of LDL cholesterol simultaneously with HDL.

A dependence was also found between the lipid profile and obesity. Experts of the American Heart Association (AHA) stress that obesity is an independent risk factor for cardiovascular diseases, including hypertension, due to its association with an increase in the concentrations of LDL, triacylglycerols, glucose and blood pressure, as well as a reduction of HDL level [2]. In the examined cohort of patients HDL was observed to decrease with an increase in body weight and BMI, as well as an increase in TC followed an increase in WHR. Moreover, an elevated blood glucose level was recorded in 65% of men and 25% of women. Similar observations in a cohort of patients with primary arterial hypertension were made by Suliburska *et al*. [3]. At the same time, as many as 45% of women and 35% of men obtained excessive amounts of energy from sucrose, which was also confirmed in other studies [3].

It was additionally found that the value of systolic pressure depends on the intake of energy, fat and cholesterol, but it is also connected with body weight. It is stressed by AHA experts that a reduction of body weight as well as calorie deficit contributes to a reduction of arterial blood pressure, while an adequate intake of energy promotes control of body weight [2]. It was confirmed in the examined population that diet correlates with body weight and nutritional status indexes (WHR, BMI, waist circumference).

Conclusions

Based on the conducted analyses in the cohort of patients diagnosed with arterial hypertension, it may be stated that:

- a considerable percentage of these individuals are overweight or obese;
- in hypertensive patients lipid metabolism disorders are accompanied by elevated blood glucose levels;
- DFR was deficient in energy, carbohydrates, dietary fibre, PUFA and folates;
- examined individuals obtained excessive amounts of energy from fat and SFA and had high cholesterol intakes;
- inappropriate diet was significantly correlated with nutritional status, lipid profile and arterial blood pressure.

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Disclosure

Authors report no conflicts of interest.

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